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Shaft Design on Strength Basis Formulas

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List of 16 Shaft Design on Strength Basis Formulas

Shaft Design on Strength Basis

1) Axial Force given Tensile Stress in Shaft

$$\text{fx } P_{ax} = \sigma_t \cdot \pi \cdot \frac{d^2}{4}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$\text{ex } 125767.1\text{N} = 72.8\text{N/mm}^2 \cdot \pi \cdot \frac{(46.9\text{mm})^2}{4}$$

2) Bending Moment given Bending Stress Pure Bending

$$\text{fx } M_b = \frac{\sigma_b \cdot \pi \cdot d^3}{32}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 1.8\text{E}^6\text{N*mm} = \frac{177.8\text{N/mm}^2 \cdot \pi \cdot (46.9\text{mm})^3}{32}$$

3) Bending Stress given Normal Stress

$$\text{fx } \sigma_b = \sigma_x - \sigma_t$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 177.8\text{N/mm}^2 = 250.6\text{N/mm}^2 - 72.8\text{N/mm}^2$$



4) Bending Stress in Shaft Pure Bending Moment

$$fx \quad \sigma_b = \frac{32 \cdot M_b}{\pi \cdot d^3}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 177.8 \text{N/mm}^2 = \frac{32 \cdot 1800736.547 \text{N*mm}}{\pi \cdot (46.9 \text{mm})^3}$$

5) Diameter of Shaft given Bending Stress Pure Bending

$$fx \quad d = \left(\frac{32 \cdot M_b}{\pi \cdot \sigma_b} \right)^{\frac{1}{3}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 46.9 \text{mm} = \left(\frac{32 \cdot 1800736.547 \text{N*mm}}{\pi \cdot 177.8 \text{N/mm}^2} \right)^{\frac{1}{3}}$$

6) Diameter of Shaft given Tensile Stress in Shaft

$$fx \quad d = \sqrt{4 \cdot \frac{P_{ax}}{\pi \cdot \sigma_t}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 46.90001 \text{mm} = \sqrt{4 \cdot \frac{125767.1 \text{N}}{\pi \cdot 72.8 \text{N/mm}^2}}$$



7) Diameter of Shaft given Torsional Shear Stress in Shaft Pure Torsion

$$\text{fx } d = \left(16 \cdot \frac{Mt_{\text{shaft}}}{\pi \cdot \tau} \right)^{\frac{1}{3}}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$\text{ex } 46.9\text{mm} = \left(16 \cdot \frac{329966.2\text{N}\cdot\text{mm}}{\pi \cdot 16.29\text{N}/\text{mm}^2} \right)^{\frac{1}{3}}$$

8) Maximum Shear Stress in Shaft Bending and Torsion

$$\text{fx } \tau_{\text{smax}} = \sqrt{\left(\frac{\sigma_x}{2} \right)^2 + \tau^2}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$\text{ex } 126.3545\text{N}/\text{mm}^2 = \sqrt{\left(\frac{250.6\text{N}/\text{mm}^2}{2} \right)^2 + (16.29\text{N}/\text{mm}^2)^2}$$

9) Normal Stress given Both Bending and Torsional act on Shaft

$$\text{fx } \sigma_x = \sigma_b + \sigma_t$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$\text{ex } 250.6\text{N}/\text{mm}^2 = 177.8\text{N}/\text{mm}^2 + 72.8\text{N}/\text{mm}^2$$

10) Normal Stress given Principal Shear Stress in Shaft Bending and Torsion

$$\text{fx } \sigma_x = 2 \cdot \sqrt{\tau_{\text{max}}^2 - \tau^2}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$\text{ex } 250.6011\text{N}/\text{mm}^2 = 2 \cdot \sqrt{(126.355\text{N}/\text{mm}^2)^2 - (16.29\text{N}/\text{mm}^2)^2}$$



11) Power transmitted by Shaft

$$fx \quad P = 2 \cdot \pi \cdot N \cdot M_t$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 8.834159kW = 2 \cdot \pi \cdot 1850rev/min \cdot 45600N*mm$$

12) Tensile Stress given Normal Stress

$$fx \quad \sigma_t = \sigma_x - \sigma_b$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 72.8N/mm^2 = 250.6N/mm^2 - 177.8N/mm^2$$

13) Tensile Stress in Shaft when it is Subjected to Axial Tensile Force

$$fx \quad \sigma_t = 4 \cdot \frac{P_{ax}}{\pi \cdot d^2}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 72.80002N/mm^2 = 4 \cdot \frac{125767.1N}{\pi \cdot (46.9mm)^2}$$

14) Torsional Moment given Torsional Shear Stress in Shaft Pure Torsion



$$fx \quad M_{t_shaft} = \tau \cdot \pi \cdot \frac{d^3}{16}$$

[Open Calculator !\[\]\(e50091943b385fe16d3277389202856f_img.jpg\)](#)

$$ex \quad 329966.2N*mm = 16.29N/mm^2 \cdot \pi \cdot \frac{(46.9mm)^3}{16}$$




15) Torsional Shear Stress given Principal Shear Stress in Shaft 

$$\text{fx } \tau = \sqrt{\tau_{\max}^2 - \left(\frac{\sigma_x}{2}\right)^2}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$\text{ex } 16.29405\text{N/mm}^2 = \sqrt{(126.355\text{N/mm}^2)^2 - \left(\frac{250.6\text{N/mm}^2}{2}\right)^2}$$

16) Torsional Shear Stress in Shaft Pure Torsion 

$$\text{fx } \tau = 16 \cdot \frac{Mt_{\text{shaft}}}{\pi \cdot d^3}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$\text{ex } 16.29\text{N/mm}^2 = 16 \cdot \frac{329966.2\text{N*mm}}{\pi \cdot (46.9\text{mm})^3}$$









Variables Used

- **d** Diameter of Shaft on Strength Basis (*Millimeter*)
- **M_b** Bending Moment in Shaft (*Newton Millimeter*)
- **M_t** Torque Transmitted by Shaft (*Newton Millimeter*)
- **M_{tshaft}** Torsional Moment in Shaft (*Newton Millimeter*)
- **N** Speed of Shaft (*Revolution per Minute*)
- **P** Power Transmitted by Shaft (*Kilowatt*)
- **P_{ax}** Axial Force on Shaft (*Newton*)
- **σ_b** Bending Stress in Shaft (*Newton per Square Millimeter*)
- **σ_t** Tensile Stress in Shaft (*Newton per Square Millimeter*)
- **σ_x** Normal Stress in Shaft (*Newton per Square Millimeter*)
- **T_{max}** Principal Shear Stress in Shaft (*Newton per Square Millimeter*)
- **T_{smax}** Maximum Shear Stress in Shaft (*Newton per Square Millimeter*)
- **τ** Torsional Shear Stress in Shaft (*Newton per Square Millimeter*)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **sqrt**, sqrt(Number)
A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- **Measurement:** **Length** in Millimeter (mm)
Length Unit Conversion 
- **Measurement:** **Power** in Kilowatt (kW)
Power Unit Conversion 
- **Measurement:** **Force** in Newton (N)
Force Unit Conversion 
- **Measurement:** **Frequency** in Revolution per Minute (rev/min)
Frequency Unit Conversion 
- **Measurement:** **Torque** in Newton Millimeter (N*mm)
Torque Unit Conversion 
- **Measurement:** **Stress** in Newton per Square Millimeter (N/mm²)
Stress Unit Conversion 



Check other formula lists

- [Maximum Shear Stress and Principal Stress Theory Formulas](#) 
- [Shaft Design on Strength Basis Formulas](#) 

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